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International tourism, energy consumption, and environmental pollution: The case of Turkey

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ABSTRACT

This study investigates the long-run equilibrium relationship between tourism, energy consumption, and environmental degradation as proxied by carbon dioxide (CO_2) emissions in Turkey, which attracts more than 30 million tourists per year, making it the sixth most visited country in the world. The study results reveal that tourism and energy consumption are in a long-term equilibrium relationship with CO_2 emissions; in the tourism-induced model, CO_2 emissions converge to the long-term equilibrium path by a 91.01 percent speed of adjustment every year through the channels of tourism, energy consumption, and aggregate income. Further, the results of the impulse response and variance decompositions reveal that the reaction of energy consumption, and therefore CO_2 emissions, to changes in tourism development is positive and gains strength in the longer periods. This implies that tourism development in Turkey has resulted not only in considerable increases in energy use but also considerable increases in climate change, as demonstrated by the econometric analysis of this study.

Contents

1. Introduction

There have been many attempts in the energy economics literature to determine the link between energy, environmental degradation or pollution, and economic growth. Climate change is regarded as one of the proxies for environmental degradation in the literature, and climate change has also been extensively proxied by carbon dioxide (CO_2) emissions. However, the relationship of energy and climate change with particular segments or sectors of the economy deserves attention. One such sector is that of international tourism. Development in international tourism and an increase in the number of international tourists not only contribute to a country's economy but also lead to an increase in energy consumption. However, tourism development is also likely to bring about changes to the climate through different channels; for example, an increase in tourism activities comes with an increased demand for energy within various functions, such as transportation, catering, accommodation, and the management of

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tourist attractions [1–3], which is also likely to lead to environmental degradation and pollution. This degradation is, for example, channeled through fuel consumption. In this respect, an investigation of the relationship between tourism, the energy sector (that is, energy consumption), and climate change is of immense significance to both policy makers and practitioners. Furthermore, in 2002, the World Summit on Sustainable Development in Johannesburg acknowledged international tourism as one of the major energy-consuming sectors [4].

In general, the energy economics literature has focused on the link between economic growth, energy consumption, and climate change, but the results remain inconclusive [see, for example, 5–14]. Some studies have investigated the relationship between energy consumption and real income growth [5,15–17]; some have tested the validity of the environmental Kuznets curve hypothesis (in search of the relationship between climate change and real income growth) [18–22]; and some have investigated the joint impact of energy consumption and aggregate output on climate change in previous literature [23–26].

Since an increase in tourism activities comes with an increased demand for energy within various functions, as mentioned before, the importance of energy for the tourism sector is undeniable. Consequently, it is expected that as the tourism sector develops, it will rely increasingly on energy. Hence, it will lead to an increase in energy consumption. However, the increased energy consumption due to tourism development may have a negative impact on the quality of the environment via climate change. It is evident that environmental degradation is likely to occur also as a result of tourism development through the construction of hotels and other tourist establishments via energy consumption.

A relatively smaller strand of the literature has studied the issue of tourism and energy consumption mainly from the perspective of its implications regarding environmental issues, such as its contribution to greenhouse gas emissions and global warming [2,3,27–29]. On the other hand, only a few studies have focused on the link between tourism and electricity consumption [see, for instance, 1,2,4,30–35]. The link between energy, the environment, and international tourism has received little consideration from different perspectives in the related literature. Nepal [4] found that although primary energy sources include wood and kerosene, the use of renewable energy and locally developed energy-saving technologies has increased in the tourism sector of Nepal. On the other hand, Gossling [3] estimated that global tourism-related energy consumption is 14,080 PJ (power joule). Of this amount, 94 percent belongs to the transportation sector, 3.5 percent to accommodation, and the remainder to the activities sector. However, to the best of our knowledge, only the studies of Katircioglu et al. [36] and Lee and Brahmasrene [37] have investigated the empirical econometric interactions between tourism, energy consumption, and climate change. These two studies confirmed the long-term economic association between tourism growth, energy consumption, and climate change; Katircioglu et al. [36] found positive effects of tourism growth on climate change in the case of the south of Cyprus, while Lee and Brahmasrene [37] confirmed the negative effects of tourism on climate change in the case of European Union (EU) countries.

1.1. *Aim and importance of the study*

Against this backdrop, the present study employs bounds tests to level the relationships, conditional error correction model, impulse response, and variance decomposition analyses in order to investigate the long-run equilibrium relationship between tourism and energy/climate change in Turkey. Turkey is a large country located in a strategic region of the world. International tourist arrivals to Turkey were about 34.038 million (46.59 percent of the country's population) in 2011, ranking it sixth in the world for attracting international tourists [38], and, again in 2011, tourism receipts totaled 28.05 billion USD (3.62 percent of the gross domestic product), which ranks tenth out of generating tourism receipts in the globe [36]. Table 1 provides an overview of the tourist arrivals to Turkey in addition to the CO_2 emissions and energy consumption. These figures suggest that tourism development in Turkey is likely to affect climate change and energy consumption.

Table 1
Overview of tourism, CO_2 emissions, and energy use in Turkey.
Source: World development indicators [45].

Years	International tourist arrivals (thousands)	CO_2 emissions (kt)	Energy use (kt of oil equivalent)
1960	124.2	16,806.8	10,690.0
1965	361.8	27,366.4	13,811.0
1970	724.8	42,605.0	18,212.0
1975	1148.6	65,644.2	26,756.0
1980	1057.4	75,701.9	31,445.0
1985	2190.2	106,629.7	39,316.0
1990	5397.7	150,667.3	52,756.0
1995	7747.4	176,560.8	61,545.0
2000	10,428.2	215,970.8	76,348.0
2001	11,619.9	194,378.9	70,402.0
2002	13,248.2	205,510.1	74,248.0
2003	13,956.4	218,330.4	77,834.0
2004	17,548.4	225,222.4	80,858.0
2005	21,124.9	237,174.4	84,379.0
2006	19,819.8	261,356.8	93,035.0
2007	26,122.0	288,658.2	100,005.0
2008	29,637.0	285,274.3	98,501.7
2009	30,435.0	277,844.9	97,660.6
2010	31,396.0	298,002.4	105,133.1

On the other hand, we must note that although these figures show how important international tourism is for the Turkish economy, the results of the investigations into the role of international tourism in the economic growth of this developing country are inconclusive in the literature. Utilizing leveraged bootstrap causality tests, Gunduz and Hatemi-J [39] empirically confirmed the Tourism-Led Growth (TLG) hypothesis for Turkey. They found unidirectional causality running from international tourist arrivals to Turkey's economic growth. Using the Johansen technique and vector error correction modeling, Ongan and Demiroz [40] investigated the impact of international tourism receipts on Turkey's long-term economic growth. They found bidirectional causality between international tourism and economic growth, suggesting that an expansion in international tourism stimulates growth in the Turkish economy, and growth in the Turkish economy stimulates an expansion in international tourism. However, unlike the findings of Gunduz and Hatemi-J [39] and Ongan and Demiroz [40], Katircioglu [41] rejected the TLG hypothesis for the Turkish economy using the Johansen approach and the bounds test for level relationships. Katircioglu [41] ran two tests using the whole data period of 1960–2006, but neither revealed any long-run relationship between international tourism and economic growth in Turkey. Finally, Arslanturk et al. [42] investigated the time-varying linkages between tourism receipts and economic growth in Turkey and found that the results from the full sample suggested no Granger causality between tourism receipts and real income, while the findings from the time-varying coefficients model based on the state-space model and rolling window technique showed that tourism receipts had positive–predictive content for real income following the early 1980s.

Previous research has shown that further investigations are required into international tourism in Turkey; therefore, the results of the present study will offer further insight to other

researchers in the field. The rest of the article is structured as follows. Section 2 defines the theoretical setting of the present study; Section 3 discusses the data and methodology; Section 4 presents the empirical results and discussions; and Section 5 concludes the article.

2. Theoretical setting

As mentioned in Section 1, the literature has shown that environmental pollution is mainly proxied by CO_2 emissions (kt). Many studies, such as that of Katircioglu et al. [36], have discussed climate change. The starting point of the theoretical setting in the present study is that international tourist arrivals might be a determinant of climate change. In addition to energy consumption, many studies have identified gross domestic product as a major contributor to climate change. Thus, the following tourism-induced functional relationship is proposed in the present study:

$$CO_{2t} = f(GDP_t, E_t, T_t), \tag{1}$$

where CO_2 is a proxy for climate change in (kt), GDP is gross domestic product, E is energy use (kt of oil equivalent), and T is tourism volume.

The functional relationship in Eq. (1) can be expressed in logarithmic form to capture the growth impacts (elasticity coefficients) in the economic long-term period [43]:

$$\ln CO_{2t} = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \ln E_t + \beta_3 \ln T_t + \varepsilon_t, \tag{2}$$

where at period t, $\ln CO_2$ is the natural log of the climate change variable; ln GDP is the natural log of the gross domestic product; $\ln E$ is the natural log of energy consumption; $\ln T$ is the natural log of tourism volume; and ε is the error disturbance.

The dependent variable in Eq. (2) may not immediately adjust to its long-run equilibrium level following a change in any of its determinants. Therefore, the speed of adjustment between the short-run and long-run levels of the dependent variable can be captured by estimating the following error correction model:

$$\begin{aligned}\Delta \ln CO_{2t} = a_0 + \sum_{i=1}^{n} b_1 \Delta \ln CO_{2t-j} + \sum_{i=0}^{n} c_2 \Delta \ln GDP_{t-j} \\ + \sum_{i=0}^{n} d_3 \Delta \ln E_{t-j} + \sum_{i=0}^{n} e_4 \Delta \ln T_{t-j} + \gamma_5 \varepsilon_{t-1} + u_t,\end{aligned} \tag{3}$$

where Δ represents a change in the $\ln CO_2$, $\ln E$, and $\ln T$ variables and ε_{t-1} is the one period lagged error correction term (ECT), which is estimated from Eq. (2). The ECT in Eq. (3) shows how fast the disequilibrium between the short-run and the long-run values of the dependent variable is eliminated in each period. The expected sign of the ECT is negative [see 44].

3. Data and methodology

3.1. Data

The data used in this paper are annual figures covering the period 1960–2010 and the variables of the study are CO_2 emissions in (kt) standing for climate change (CO_2), gross domestic product (GDP) (2005=100), energy use (kt of oil equivalent) (E), and the total number of international tourists arriving and staying in Turkey's tourist establishments (T). The data for CO_2, GDP, and E were obtained from the World Bank Development Indicators [45], while T was obtained from TURKSTAT [46].

There are several alternatives for measuring tourism volume in the literature, as Katircioglu [41] mentioned. These include tourism receipts, the number of nights spent by visitors from abroad, and the number of international tourist arrivals. The tourism variable in the present study was proxied by the number of international tourists visiting Turkey and staying in the tourist establishments. On the other hand, in correspondence with the previous works in the energy literature, the energy variable in the present study is proxied by energy use (kt of oil equivalent), and the environmental pollution (climate change) variable is proxied by CO_2 emissions (kt).

3.2. Unit root tests

The present study employs the Zivot and Andrews (ZA) [47] test for the unit root. This is because of a potential problem with the conventional unit root tests: As Fig. 1 indicates, there are breaks in the series of this study. Thus, the time series properties of the variables of the study are likely to be affected by these breaks. In the literature, Perron [48] was the first to demonstrate that if there are breaks in the series, then the power of the unit root tests may be affected such that the null of non-stationarity is under-rejected. Zivot and Andrews [47] argued that under the alternative hypothesis, the breakpoint should be treated as unknown, and by not doing this, Perron [48] biased his results in favor of the rejection of the unit root hypothesis. Zivot and Andrews [47] utilized the same modeling framework as Perron [48], but with an unknown breakpoint instead of a known breakpoint, as in Perron [48]. Therefore, the ZA [47] unit root tests with a single break are employed in the present study.

3.3. Bounds tests

To investigate the long-run relationship between the variables under consideration, the bounds test within the autoregressive distributed lag (ARDL) modeling approach was adopted. This approach was developed by Pesaran et al. [49] and can be applied irrespective of the order of integration of the variables (irrespective of whether the regressors are purely I (0), purely I (1), or mutually co-integrated). The ARDL modeling approach involves estimating the following error correction model:

$$\begin{aligned}\Delta \ln CO_{2t} = a_0 + \sum_{i=1}^{n} b_i \Delta \ln CO_{2t-i} + \sum_{i=0}^{n} c_i \Delta \ln GDP_{t-i} \\ + \sum_{i=0}^{n} d_i \Delta \ln E_{t-i} + \sum_{i=0}^{n} e_i \Delta \ln T_{t-i} + \sigma_1 \ln CO_{2t-1} \\ + \sigma_2 \ln GDP_{t-1} + \sigma_3 \ln E_{t-1} + \sigma_4 \ln T_{t-1} + \varepsilon_t\end{aligned} \tag{4}$$

In Eq. (4), Δ is the difference operator, and ε_t is the serially independent random error with mean zero and a finite covariance matrix.

Again, in Eq. (4), the *F-test* is used for investigating a (single) long-term relationship. In the case of a long-term relationship, the *F-test* indicates which variable should be normalized. In Eq. (4), when $\ln CO_2$ is the dependent variable, the null hypothesis of no level relationship is H_0: $\sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = 0$ and the alternative hypothesis of a level relationship is H_1: $\sigma_1 \neq \sigma_2 \neq \sigma_3 \neq \sigma_4 \neq 0$.

In the present study, the conditional ECM using the ARDL approach is employed in the case of a level relationship to estimate the short-term coefficients plus the error correction term, as well as the long-term coefficients in Eq. (2). In addition, as also suggested by Pesaran et al. [49], the time series properties of the key variables (CO_2, GDP, E, and T) in the conditional ECM of the present study can be approximated by double-log error correction at lag levels that might differ for each explanatory variable, augmented with appropriate deterministics, such as the intercept and time trend. Eq. (3) of the present study is used to estimate the conditional error correction model, where β_5 is the coefficient of the error correction term.

In the final step, the impulse responses plus the variance decomposition for the variables are estimated. The impulse

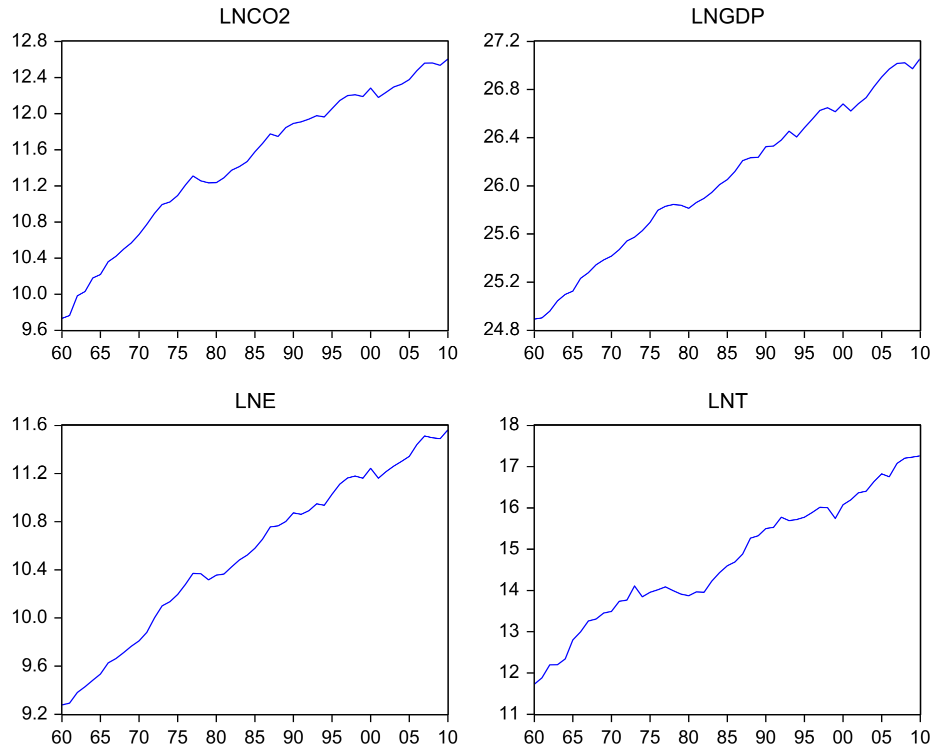

Fig. 1. Line plots of logarithmic series.

Table 2
ZA [47] tests for unit root under a single structural break.

	Statistics (Level)			Statistics (First difference)			
	ZA_B	ZA_T	ZA_I	ZA_B	ZA_T	ZA_I	Conclusion
ln CO_2	−3.361	−3.319	−2.864	−8.768*	−8.460*	−8.633*	I (1)
Break Year	**1971**	**1974**	1998	1982	1980	1978	
Lag length	0	0	0	0	0	0	
ln GDP	−4.935***	−4.908*	−4.177	−7.440*	−7.323*	−7.517*	I (0)
Break Year	1978	1976	1971	1983	1981	1978	
Lag length	3	3	3	0	0	0	
ln E	−4.054	−3.663	−3.359	−7.517*	−7.021*	−7.566*	I (1)
Break Year	1972	1976	1972	1978	1981	1978	
Lag length	0	0	0	0	0	0	
ln T	−6.197*	−4.398***	−4.815***	−9.248*	−8.308*	−8.523*	I (0)
Break Year	1978	1983	1978	1983	1975	1983	
Lag length	8	4	4	0	0	0	

Notes: CO_2 is carbon dioxide emissions; GDP is gross domestic product; E is energy use (consumption); T is international tourist arrivals to Turkey. All of the series are at their natural logarithms. ZA_B represents the model with a break in both the trend and intercept; ZA_T is the model with a break in the trend; ZA_I is the model with a break in the intercept. *, **, and *** denote the rejection of the null hypothesis at the 1 percent, 5 percent, and 10 percent levels, respectively. Tests for unit roots were carried out in E-VIEWS 7.2.

Table 3
Critical values for the ARDL modeling approach.
Source: Narayan [50] for F-statistics and Pesaran et al. [49] for t-ratios.

$k=3$	0.10		0.05		0.01	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
F_{IV}	3.378	4.274	4.048	5.090	5.666	6.988
F_V	3.868	4.965	4.683	5.980	6.643	8.313
F_{III}	3.008	4.150	3.710	5.018	5.333	7.063
t_V	−3.130	−3.840	−3.410	−4.160	−3.960	−4.730
t_{III}	−2.570	−3.460	−2.860	−3.780	−3.430	−4.370

Notes: (1) k is the number of regressors for the dependent variable in ARDL models; F_{IV} represents the F statistic of the model with unrestricted intercept and restricted trend; F_V represents the F statistic of the model with unrestricted intercept and trend; and F_{III} represents the F statistic of the model with unrestricted intercept and no trend. (2) t_V and t_{III} are the t-ratios for testing $\sigma_1=0$ in Eq. (4) with and without deterministic linear trend (these notes are adapted from Katircioglu [43]).

Table 4
The bounds test for level relationships.

Variables	With deterministic trend			Without deterministic trend		Conclusion
	F_{IV}	F_V	t_V	F_{III}	t_{III}	
						H_0
FCO_2(ln CO_2/ln GDP, ln E, ln T)						
$p=2$*	8.952[a]	5.222[a]	−2.739[b]	11.490[a]	−3.397[c]	Rejected
3	2.763[b]	1.867[b]	−0.967[b]	3.564[c]	−1.139[b]	
4	3.392[c]	1.904[b]	−1.380[b]	4.358[c]	−1.490[b]	
5	2.817[b]	1.469[b]	−0.177[b]	3.650[c]	−0.459[b]	

Note: Schwartz Criteria (SC) were used to select the number of lags required in the bounds test. p shows lag levels and * denotes the optimum lag selection in each model as suggested by SC. F_{IV} represents the F statistic of the model with unrestricted intercept and restricted trend; F_V represents the F statistic of the model with unrestricted intercept and trend; and F_{III} represents the F statistic of the model with unrestricted intercept and no trend. t_V and t_{III} are the t-ratios for testing $\sigma_1=0$ in Eq. (4) with and without deterministic linear trend.

[a] Lies above the upper bound (these notes are adapted from Katircioglu [43]).
[b] Statistic lies below the lower bound.
[c] Falls within the lower and upper bounds.

responses would denote how the series react to exogenous shocks in another over the periods, while the variance decompositions would determine how much of the forecast error variance of the dependent variable can be explained by exogenous shocks to the independent variables. The impulse responses and variance decompositions are expected to be complementary to the ECM and causality tests.

4. Results and discussion

Table 2 gives the unit root test results for the variables under consideration. The ZA [47] test suggests that the gross domestic product (GDP) and tourist arrivals to Turkey are stationary at levels, while CO_2 emissions and energy use (E) are non-stationary at their levels, but become stationary at the first differences. This conclusion has been reached by running the ZA [47] tests under three scenarios: with break in trend and intercept, with break in trend, and with break in intercept. The null hypothesis of a unit root can be rejected in the cases of ln GDP and ln T at their levels, while it cannot be rejected in the cases of ln CO_2 and ln E. To summarize, the unit root tests in this study suggest that GDP and T are integrated of order zero, $I(0)$, whereas CO_2 and E are said to be integrated of order one, $I(1)$.

The ZA [47] unit root tests provide mixed results for the order of integration; therefore, bounds tests for level relationships are employed to investigate the long-run equilibrium relationship between international tourist arrivals and CO_2 emissions/energy use. The use of bounds tests through the ARDL modeling approach was suggested by Pesaran et al. [48]. The critical values for F *statistics* (for $n=50$ observations in this study) are presented in Table 3, as taken from Narayan [50]. Table 4 gives the results of the bounds tests for level relationships in two different models where international tourism is assumed to be a determinant of CO_2 in the first model and of energy use in the second model. These two models are run under three different scenarios, as suggested by Pesaran et al. [49]: with restricted deterministic trends (F_{IV}), with unrestricted deterministic trends (F_V), and without deterministic trends (F_{III}). The intercepts in these scenarios are all unrestricted.[1]

The results in Table 4 indicate that the application of the bounds *F-test* using the ARDL modeling approach suggest a level relationship in Eq. (4), where CO_2 is the dependent variable and GDP, E, and T are regressors. This is because the null hypothesis of H_0: $\sigma_1=\sigma_2=\sigma_3=\sigma_4=0$ in Eq. (4) can be rejected. All of the

[1] For detailed information, please refer to Pesaran et al. [49], pp. 295–296.

Table 5
Dependent variable: CO_2.
Lag structure: (8, 8, 7, 8) (With deterministic trend).

Regressor	Coefficient	Standard error	p-Value
$\hat{u}_{t-1}$	−0.910184	0.186028	0.0005
Δln CO_{2t-1}	−0.133337	0.149326	0.3910
Δln CO_{2t-2}	−0.130877	0.154055	0.4137
Δln CO_{2t-3}	−0.712930	0.211376	0.0062
Δln CO_{2t-4}	−1.283320	0.309011	0.0016
Δln CO_{2t-5}	−1.034001	0.344957	0.0121
Δln CO_{2t-6}	−0.996819	0.289146	0.0055
Δln CO_{2t-7}	−0.533551	0.152610	0.0050
Δln GDP	−0.563760	0.178975	0.0092
Δln GDP_{t-1}	1.535064	0.362243	0.0014
Δln GDP_{t-2}	1.012888	0.250562	0.0019
Δln GDP_{t-3}	0.866282	0.199294	0.0012
Δln GDP_{t-4}	0.846705	0.232472	0.0039
Δln GDP_{t-5}	0.588284	0.233104	0.0283
Δln GDP_{t-6}	0.214773	0.176724	0.2497
Δln GDP_{t-7}	0.515127	0.172115	0.0122
Δln E	1.642463	0.155445	0.0000
Δln E_{t-1}	−0.719010	0.225597	0.0087
Δln E_{t-2}	−0.273092	0.244922	0.2886
Δln E_{t-3}	0.571683	0.255850	0.0472
Δln E_{t-4}	0.960974	0.320377	0.0121
Δln E_{t-5}	0.865013	0.323396	0.0216
Δln E_{t-6}	0.677102	0.308198	0.0504
Δln T	−0.021082	0.031561	0.5179
Δln T_{t-1}	0.024862	0.036318	0.5078
Δln T_{t-2}	−0.035683	0.029337	0.2493
Δln T_{t-3}	0.054403	0.032016	0.1173
Δln T_{t-4}	0.134009	0.035179	0.0029
Δln T_{t-5}	0.066280	0.037573	0.1054
Δln T_{t-6}	0.148446	0.032051	0.0007
Δln T_{t-7}	0.039282	0.038164	0.3254
Intercept	0.038096	0.022159	0.1135

Adj. $R^2=0.923$, S.E. of Regr.$=0.014$.
AIC$=-5.528$, SBC$=-4.217$.
F-stat.$=17.332$, F-prob.$=0.000$.
D–W stat.$=2.180$.

alternative scenarios from Pesaran et al. [49] (namely, F_{III}, F_{IV}, and F_V) enable us to reject this null hypothesis; therefore, we can conclude that the CO_2 emissions in Turkey are in a level relationship with the gross domestic product, energy consumption, and tourism volume. The results from the application of the bounds *t-test* in each ARDL model in Table 4 do not allow for the imposition of trend restrictions, since the t-ratios to test for H_0: $\sigma_1=0$ are not statistically significant [see 49, p. 312].

The level relationship obtained in Eq. (4) does allow for the adoption of the ARDL approach to estimate the level coefficients,

as also discussed in Pesaran and Shin [51]. The resulting estimate of the level relationship under the ARDL specification presented in Eq. (2) is given below as follows:

Long-run model in Eq. (2):

$$\ln CO_{2t} = \underset{(0.002)}{1.136}\ (\ln GDP_t) + \underset{(0.000)}{1.932}\ (\ln E_t) + \underset{(0.048)}{0.106}\ (\ln T_t) + 0.179 + \hat{u}_t$$

Numbers in brackets in the above estimation are p-values of each estimated coefficient. The coefficient of T is positively inelastic, and statistically significant which implies that in the long-term period, a 1 percent change in tourist arrivals to Turkey will lead to a 0.106 percent change in CO_2 emissions in the same direction. The coefficient of E is positive, elastic, and statistically significant. This implies that in the long-term period in the case of Turkey, a 1 percent change in energy consumption will lead to a 1.932 percent change in CO_2 emissions in the same direction. In addition, the long-term coefficient of GDP is positively inelastic and statistically significant.

In the next stage, the conditional ECM regression associated with the level relationship in Eq. (2) should be estimated. The ECM estimation from Eq. (3) is provided in Table 5.

The ECT term in Eq. (3) when CO_2 is the dependent variable is −0.9101, statistically significant, and negative. Table 5 implies that CO_2 emissions converge to their long-term equilibrium path by a 91.01 percent speed of adjustment through the channels of tourism and energy consumption. The short-term coefficients of energy consumption and GDP are again elastic, positive, and statistically significant at the initial period but become inelastic in the later periods. The short-term coefficients of the tourism variable in the short-term periods are positive and statistically significant at lags 4 and 6 which reveal that the tourism variable exerts positive and statistically significant effects on CO_2 emissions in the shorter periods. The summary test results in Table 5 show that there is no autocorrelation in the estimation. The main finding of the ECM is that CO_2 emissions in Turkey react to their long-term path significantly in the tourism-induced model proposed in this study.

Fig. 2 presents the line plots of the impulse response functions among the series under consideration. The response of CO_2 emissions to a shock in GDP is shown to be positive, and its power increases over time, implying that the output growth in Turkey results in increases in CO_2 emissions. It is interesting to observe that the response of CO_2 emissions to a shock in overall energy

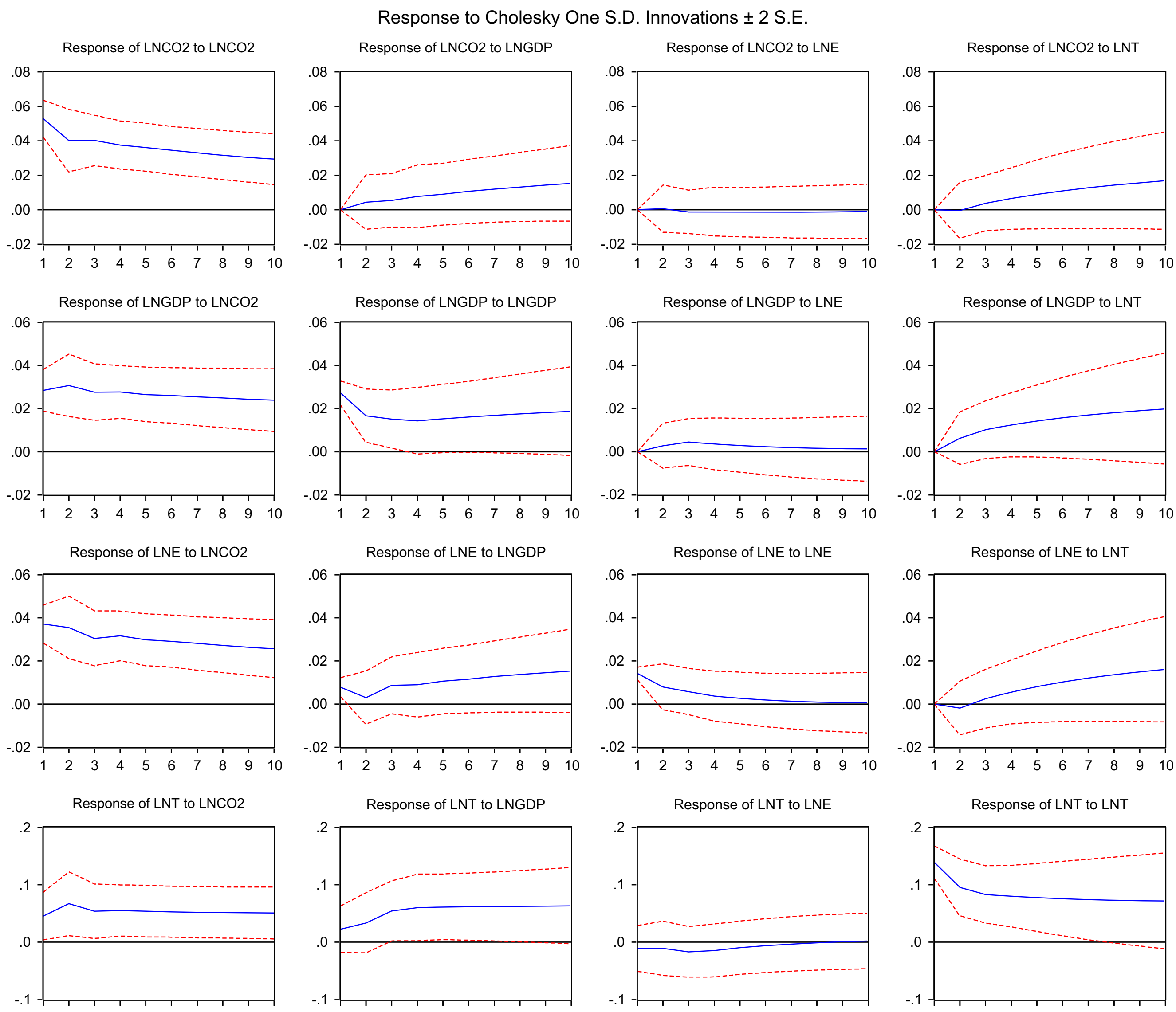

Fig. 2. Impulse responses.

Table 6
Variance decomposition analysis.

Period	S.E.	ln CO_2	ln GDP	ln E	ln T
Variance decomposition of ln CO_2					
1	0.052803	100.0000	0.000000	0.000000	0.000000
2	0.066396	99.55396	0.434350	0.007881	0.003806
3	0.077869	98.94249	0.790483	0.033612	0.233420
4	0.087007	97.79315	1.417195	0.045274	0.744377
5	0.095082	96.37797	2.069762	0.063664	1.488603
6	0.102241	94.63999	2.862693	0.076838	2.420475
7	0.108839	92.70501	3.717100	0.086655	3.491233
8	0.114989	90.61086	4.638297	0.091412	4.659428
9	0.120816	88.42216	5.595793	0.092325	5.889721
10	0.126388	86.17728	6.578857	0.090179	7.153686
Variance decomposition of ln GDP					
1	0.039416	52.05394	47.94606	0.000000	0.000000
2	0.053146	62.09155	36.24633	0.269703	1.392411
3	0.062783	63.88934	31.75786	0.702127	3.650673
4	0.071309	64.65479	28.64860	0.802167	5.894444
5	0.078972	64.00230	27.15333	0.795573	8.048798
6	0.086197	62.90188	26.27229	0.738179	10.08765
7	0.093035	61.46345	25.85524	0.675346	12.00596
8	0.099580	59.90559	25.68241	0.615588	13.79642
9	0.105873	58.29171	25.68441	0.563232	15.46065
10	0.111953	56.68600	25.79390	0.518245	17.00185
Variance decomposition of ln E					
1	0.040495	83.86622	3.742046	12.39173	0.000000
2	0.054562	88.56775	2.362435	8.955001	0.114819
3	0.063398	88.68593	3.621347	7.456760	0.235965
4	0.071732	88.74729	4.376809	6.085039	0.790862
5	0.078865	87.70466	5.444238	5.158745	1.692355
6	0.085511	86.24596	6.458138	4.434092	2.861810
7	0.091698	84.37189	7.544404	3.876856	4.206847
8	0.097589	82.29527	8.618891	3.431883	5.653951
9	0.103231	80.08349	9.695904	3.071757	7.148848
10	0.108679	77.82288	10.75180	2.774376	8.650940
Variance decomposition of ln T					
1	0.148438	9.281229	2.310679	0.555205	87.85289
2	0.191851	17.72148	4.433007	0.657923	77.18759
3	0.223102	18.90009	9.192413	1.064775	70.84272
4	0.251067	19.71112	12.99927	1.172372	66.11724
5	0.275299	20.21968	15.76961	1.100212	62.91049
6	0.296866	20.56200	17.86962	0.988593	60.57979
7	0.316534	20.78634	19.56594	0.880016	58.76770
8	0.334788	20.94681	20.97297	0.787607	57.29261
9	0.351946	21.06178	22.16907	0.713101	56.05605
10	0.368229	21.14797	23.19966	0.654611	54.99776

consumption is almost zero and irresponsive. The reaction of CO_2 emissions to changes in the tourism volume is irresponsive in the initial periods, but starts to be positively high in the later periods at an increasing rate. The same trend is also observed in the reaction of energy consumption to a given shock in tourism: a shock in tourism volume leads to rapid changes in energy consumption in the longer periods. Therefore, again, the reaction of CO_2 emissions to a shock in tourism is consistent with the reaction of energy consumption to a shock in tourism. On the other hand, the degree of increases in CO_2 emissions due to tourism is higher than the increase due to changes in GDP, as can be seen in Fig. 2. This finding reveals that tourism development is likely to result in significant increases in variations of CO_2 emissions in the longer periods in Turkey.

Finally, Table 6 presents the variance decomposition results among the series of the study. The results show that in the initial periods, lower levels of the forecast error variance of CO_2 emissions can be explained by exogenous shocks to its determinants, which are GDP, energy consumption, and tourism volume. However, the ratios start to increase over time. For example, in period 10, 6.578 percent of the forecast error variance of CO_2 emissions is explained by the given exogenous shocks to the GDP. This ratio is 0.090 percent in the case of energy consumption and 7.153 percent in the case of tourism volume. It is important to note that the forecast error variance of CO_2 emissions due to changes in tourism is higher than the forecast error variance of CO_2 emissions due to changes in GDP and energy consumption. The findings from the variance decomposition analysis confirm the findings from the impulse responses: tourism development in Turkey leads to significant variations in CO_2 emissions not in the shorter periods but in the longer periods. Therefore, the earlier finding of the error correction term ($\beta_5 = -0.9101$, $p < 0.01$, in Eq. (3)) contains an important implication that tourism development in Turkey is a contributor to increases in CO_2 emissions. On the other hand, when the forecast error variances of energy consumption with respect to tourism volume are evaluated in Table 6, similar findings can be drawn. The forecast error variances of energy consumption can be significantly explained by the variances in tourism volume, especially in the longer periods. For example, in period 10, 8.650 percent of the forecast error variance of energy consumption can be explained by the given exogenous shocks to tourism volume. This final finding provides further empirical support to document the econometric relationship between CO_2 emissions and tourism development in Turkey.

5. Conclusion and recommendations

5.1. Conclusions

This paper empirically investigated the long-term equilibrium relationship between tourism, environmental degradation as proxied by CO_2 emissions, and energy consumption in Turkey, which is sixth among the top tourist destination countries, attracting more than 30 million international tourists every year. Hence, the justification for conducting this research is that climate change and energy use are likely to be affected by Turkey's popularity as a tourist destination. The present study proposed a tourism-induced model, where CO_2 emissions are the dependent variable and energy use and tourism volume are regressors, in addition to aggregate output. Results of this research can be summarized as follows:

- The bounds tests suggest a strong long-term equilibrium relationship between CO_2 emissions and its determinants, including tourism.
- Tourism in Turkey exerts positive and statistically significant effects on CO_2 emissions in the long-term and shorter periods.
- The estimated error correction model in the study shows that CO_2 emissions converge to the long-term equilibrium path significantly by a 91.01 percent speed of adjustment, owing to tourism development, energy consumption, and aggregate output.
- The results of the impulse responses and variance decomposition analyses show that tourism development leads to significant increases CO_2 emissions and energy consumption, especially in the longer periods; furthermore, the degree of its effects get stronger over time.
- The major finding of this study is that tourism development in Turkey is a contributor to significant increases not only in income (as also seen in Fig. 2) and energy consumption but also in CO_2 emissions.

5.2. Recommendations

The present research findings reveal some recommendations in the case of Turkey:

Since Turkey ranks sixth in terms of attracting international tourists, there are precautions in the form of successful energy conservation policies that the Turkish authorities should take in order to avoid further increases in the emission levels resulting from tourism development.

Precautions should be implemented mainly according to negotiations between Turkey and EU. There are strategies for improving the energy performance in the tourism sector that must focus mainly on assessing the energy performance and energy savings, to achieve reductions in expenditures on energy including fuel oil. Policies should embrace the principle of setting energy and environmental targets for all new buildings and redevelopment projects, which also have a strong links to strategies in the real estate sector.

Since it is not an energy intensive activity, additional electricity power and energy need which can arise from tourism can be obtained through clean energy sources, such as photovoltaic panels. Renewable energy systems which have already initiated in Turkey should also be addressed in the Turkish tourism industry, since this study has already concluded that tourism development is a contributor to energy consumption and climate change.

It would be useful to compare further research in other tourist destination countries with the results of the present study.

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